It can be shown however that if the regulatory authority adds the cost of the additional capital required by new investment projects into the allowed rate of return, and if there is no regulatory lag, the utility will realize an appropriate compensatory return on incremental investment. For example, let K' be the incremental market cost of capital for a new project requiring an investment of I dollars. Regulatory authority typically would not calculate K' as a separate return. But if the cost of capital is calculated as a weighted average of the embedded cost of debt and an estimated cost of equity, the incremental cost of capital for the additional asset will add K' I dollars to the overall revenue requirements. In effect, then, if the regulatory commission incorporates the cost of additional capital into the allowed rate of return, the utility will realize K' on incremental investment, other things equal. If there is regulatory lag however, a utility's rate of return on new projects will deviate from the current capital costs. The only way to avoid this is through an arbitrary return adjustment, similar to an attrition allowance.

In summary, the rationalization of the use of book quantities instead of the more economically correct market quantities is not unreasonable for purposes of setting rates.

14.2 THE EFFECT OF CAPITAL STRUCTURE ON COST OF CAPITAL

This section describes the effects of capital structure changes on the cost of capital in an informal intuitive manner. The existence of an optimal capital structure is shown based on reasonable behavior postulates on the part of bondholders and equity holders. The next section outlines the formal theoretical justifications.

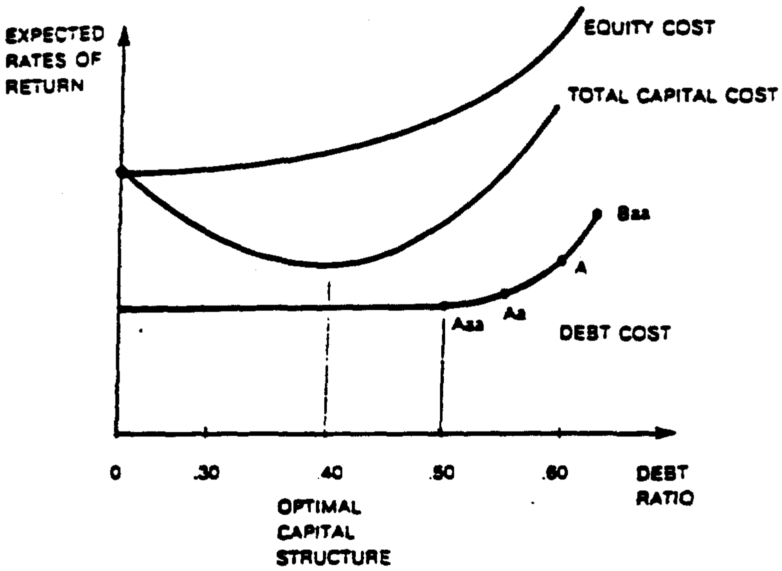
Chapter 3 described in detail the distinction between business risk and financial risk. Business risk refers to the variability of operating profits inherent in the nature of the business in which the company is engaged, regardless of its financial structure. This variability is largely induced by the external forces of supply and demand for the firm's products. Financial risk refers to the additional variability of earnings induced by the employment of fixed cost financing such as debt and preferred stock. A fundamental concept in financial theory, demonstrated in Chapter 3, is that the risk of the earnings to common shareholders increases as the financial leverage rises. As a company increases the relative amount of debt capital in its capital structure, total fixed charges increase, and the probability of failing to meet the growing fixed charge burden increases also. The residual earnings available to common stockholders become increasingly volatile and riskier as the firm increases its financial leverage, causing shareholders to require a higher return on equity.

The relationship between capital structure and the cost of capital is developed graphically in Figure 14-1. The horizontal axis is the debt ratio, D/C, assuming that no other form of senior capital exists. The graph depicts the return requirements of bondholders and shareholders in response to a change in capital structure as the firm progressively substitutes debt for equity capital.

The required return on debt is relatively flat from a debt ratio of zero up to a critical debt ratio value, say 50%. Beyond that point, an increase in debt ratio has an upward influence on bond returns as debt holders perceive a significant increase in financial risk. The actual value of the critical threshold can be determined by examining the debt ratio of utilities with the highest quality bonds (AAA). Any reduction in debt ratio below the critical point would not yield significant reductions in interest costs. The security of the bondholders' investment is not subtantially improved by additional reductions in the debt ratio. Beyond the critical point, bond returns increase

Figure 14-1

THE RELATIONSHIP BETWEEN CAPITAL STRUCTURE AND THE COST OF CAPITAL



in a manner consistent with the quality gradient observed for utility bond yields and debt ratios. The points on the bond graph in Figure 14-1 correspond to the actual bond yields and debt ratios for electric utilities rated AAA, AA, A, and BAA at a moment in time. Access to debt financing is likely to be severely curbed beyond the BAA rating level.

The curve depicting the behavior of shareholders as the debt ratio is increased is developed as follows. At a zero debt ratio, the return on equity coincides with the return on total capital since the firm is all-equity financed at that point. Beyond that point, with each successive increase in the debt ratio, equity returns rise moderately at first in response to increasing financial risk to the point where the bond ratings begin to deteriorate. As the debt ratio reaches dangerous levels where the solvency of the firm is endangered, shareholders' required returns rise sharply.

The relationship between the average cost of capital and capital structure emerges directly from the assumed behavior of bond returns and equity returns. This is also shown on Figure 14-1. At zero debt ratio, the cost of capital is coincident with the cost of equity. With each successive substitution of low-cost debt for high-cost equity, the average cost of capital declines as the weight of low-cost debt in the average increases. A low point is reached where the cost advantage of debt is exactly offset by the increased cost of equity. Beyond that point, the cost disadvantage of equity outweighs the cost advantage of debt, and the weighted cost of capital rises accordingly.

The most salient characteristic of the graph is the U-shaped nature of the cost of capital curve, pointing to the existence of an optimal capital structure whereby the cost of capital is minimized. Despite the rise of both debt and equity costs with increases in the debt ratio, the weighted average cost of capital reaches a minimum. Beyond this point, the low-cost and tax advantages of debt are outweighed by the increased equity costs. This occurs just before the point where bond ratings start deteriorating, and the cost of capital increases rapidly at higher debt ratios.

Utilities should strive for a capital structure which minimizes the composite capital cost, including taxes. Hypothetical capital structures are sometimes used by regulatory commissions to determine a fair allowed return if a utility is deemed to have deviated significantly from the optimum. A hypothetical capital structure may lower the cost of capital, which in turn may translate into lower rates for consumers as long as by using more debt, the cost and tax benefits of debt outweigh the increased equity costs.

Finding the optimal structure is easier said than done, however. The graphical relationships of Figure 14-1 are difficult to measure accurately. About the only relationship which can be charted with some confidence is the bond return graph. Observed bond yields and attendant debt ratios for comparable companies can be employed to develop such a graph. The equity return graph is difficult to construct precisely. As is evident from the previous chapters. the cost of equity is difficult enough to estimate at a given capital structure. let alone for a whole range of alternative capital structures. Nevertheless. reasonable procedures for deriving the cost of capital curve can be devised as the examples of the next chapter will demonstrate. But first the formal theory underlying the existence of an optimal capital structure will be outlined.

14.3 AN OVERVIEW OF CAPITAL STRUCTURE THEORY

No Tax Version

Assuming perfectly functioning capital markets and the absence of corporate taxes. Modigliani-Miller (1966) have argued that the value of a corporation. hence its cost of capital. is independent of capital structure. Financing decisions are irrelevant under these assumptions. The value of a firm is determined by the left-hand side of its balance sheet. that is. by the earning power of its assets. How the stream of operating income generated by the assets is apportioned among the bondholders and shareholders is irrelevant. By analogy, the value of a pie (operating income) should not depend on the manner in which it is sliced. Modigliani-Miller provide an arbitrage proof of this proposition. whereby two identical firms with differing capital structures must have the same value if riskless profit opportunities are to be avoided. Figure 14-2 shows how the overall cost of capital. hence revenue requirements. are unaffected by the debt ratio under this theory.

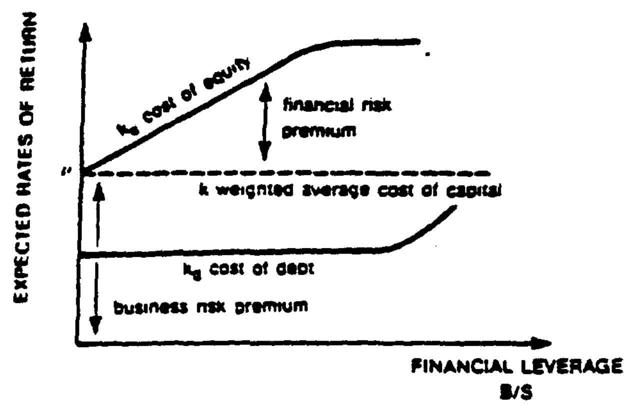
If the weighted average cost of capital remains unchanged with leverage. it follows that the required return on equity resulting from the added risk of leverage completely offsets the low-cost advantage of debt. Otherwise. the weighted average cost of capital could not remain constant. In other words. the total cost of capital remains unchanged regardless of the capital structure because the increase in required earnings resulting from greater leverage is exactly offset by the subtitution of lower cost debt for higher cost of equity. This is shown in Figure 14-2. The exact relationship between leverage and the cost of equity is linear and is expressed as:

$$K_e = p + (p - i)\ B/S \tag{14-3}$$

where p is the cost of equity for an all-equity firm. B/S is the market value leverage ratio. and 'i' is the current rate of interest. Equation 14-3 is easily derived by solving for K_e in the following equation:

Figure 14-2

THE EFFECTS OF LEVERAGE ON THE COST OF CAPITAL: NO TAX



$$K = i\ B/V + K_e\ S/V \qquad (14\text{-}4)$$

which is the straightforward definition of the weighted average cost of capital, using market value weights and returns, and by substituting 'p' for 'K'. The cost of capital for an all-equity financed firm, 'p', and the cost of capital of a levered firm, K, are identical under Modigliani-Miller's proposition.

The accounting analog to Equation 14-3, using actual returns instead of expected returns is:

$$r = R + (R - i)\ D/E \qquad (14\text{-}5)$$

where r = return on book value of equity, R = operating rate of return on assets, i = interest rate on aggregate debt, D = book value of all interest-bearing debt, E = book value of equity, T = tax rate. This result is derived in Appendix 14-A.

The major implication of either Equation 14-3 or Equation 14-3, is that two firms with different debt ratios will have different equity costs, even though they have the same business risk and the same overall cost of capital. This is shown on Figure 14-3 where firm A and firm B have debt ratios of

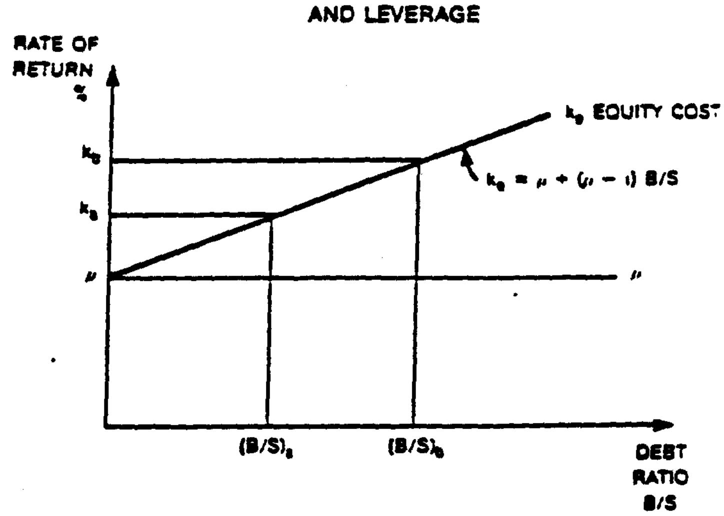
$(B/S)_a$ and $(B/S)_b$ and equity costs of K_a and K_b respectively, and yet have the same overall cost of capital K.

Introducing Corporate Income Tax

Modigliani-Miller admit that their initial thesis ignores the tax deductibility of interest payments on debt. Recognizing the income tax savings of interest payments, their argument implies a continued reduction in the cost of capital as the debt ratio is increased. Therefore, the firm's optimal capital structure is 100% debt. This is shown in Figure 14-4, where the cost of capital, thus revenue requirements, decline with each relative increment of debt capital. The value of the firm increases with the debt ratio because of the added value of the tax savings generated by debt financing. As the firm substitutes debt for equity capital, the fraction of operating income diverted to the tax authority becomes smaller, and the fraction accruing to shareholders becomes correspondingly larger. Adding debt thus enhances the value of the firm and reduces the overall cost of capital and ratepayer burden. The linear relationship between the overall cost of capital and debt ratio shown on Figure 14-4 derived from the tax-adjusted Modigliani-Miller theory can be expressed as:

Figure 14-3

THE RELATIONSHIP BETWEEN COST OF EQUITY AND LEVERAGE



APPENDIX 12

CAPITAL STRUCTURE, COST OF CAPITAL, AND REVENUE REQUIREMENTS

Capital Structure, Cost of Capital, And Revenue Requirements

By EUGENE F. BRIGHAM, LOUIS C. GAPENSKI, and DANA A. ABERWALD

This article describes a study made to determine what changes in a utility's cost of equity capital result from changes in its capital structure, and whether there is an ideal capital structure that will minimize the utility's cost of capital and its revenue requirements. From a computer model developed by the authors it was found that changes in the costs of debt and equity are offset by changes in the weights assigned to them in calculating the overall rate of return, thus creating negligible effects on the overall return and revenue requirements. The article also points out some probable consequences of recent revision of the federal income tax code in this connection.

Most electric, gas, and telephone utilities have recently been reducing their debt ratios and generally improving their balance sheets. This trend has raised two questions: (1) How do changes in capital structure affect the cost of equity? (2) Is there an optimal capital structure, defined as one that minimizes revenue requirements over the long run, and if so, what is it? The Florida Public Service Commission asked us to study these issues, and this article summarizes our analysis and conclusions.[1]

We began our analysis with a review of the business risks faced by the utilitie· This analysis indicated that, even though most utilities' positions have improved during the past two or three years, the general trend in business risk has been up, and all utilities today face more business risk than they did in the 1960s and early 1970s. Since the optimal capital structure depends heavily on business risk — the higher its business risk, the lower a company's debt ratio — the recent balance sheet improvements were appropriate.

We also examined the major theoretical and empirical works on the relationship between capital structure and capital costs, and we did some empirical work of our own. We concluded that a one percentage point change in the debt ratio causes, on average, a change of about 12 basis points in the cost of equity. However, we also found, using a computer model which we developed, that changes in the costs of debt and equity are offset by changes in the weights used to calculate the overall rate of return. As a result, the overall rate of return is not affected significantly by capital structure changes.

Our major conclusion is that capital structure deci-

[1] *The Effects of Capital Structure on Utilities' Costs of Equity and Revenue Requirements*, by E. F. Brigham, L. C. Gapenski, and D. A. Aberwald, Public Utility Research Center, University of Florida, June 30, 1986. The study was funded, at the request of the Florida commission, by the Florida Institute of Government.

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sions, within the range over which most utilities operate, have negligible effects on revenue requirements. Operating decisions, on the other hand, can and do have major effects both on the quality of service and on revenue requirements. Therefore, capital structure decisions should be focused primarily on ensuring that financial constraints do not hinder operations.

Background

In a typical rate case, the rate of return the utility is allowed to earn on its rate base is found as a weighted average cost of capital (WACC):

$$WACC = w_d k_d + w_p k_p + w_s k_s \qquad (1)$$

Here the w's are the weights and the k's are the component costs of debt, preferred, and common equity. Embedded costs are used for debt and preferred, but a current cost rate is used for common equity. The weights can be based on the actual capital structure at a given date, or on an "imputed" capital structure if there is reason to believe that the actual capital structure is for some reason inappropriate. The choice of weights can have a significant effect on the resulting weighted average cost, and that, in turn, can have a significant effect on revenue requirements, customers' bills, and the company's earnings. Thus, capital structure can be an important rate case issue.

The optimal capital structure, which minimizes a firm's WACC and hence its revenue requirements, depends primarily on the company's business risk: The higher its business risk, the lower its optimal debt ratio, other things held constant. The past twenty years have witnessed a sharp increase in business risk for all utilities — since 1965, business risk has trended up due to inflation, regulatory lag, increased competition, nuclear problems, and declining growth rates. Further, there has been a change in regulators' attitudes toward who should bear these risks, customers or investors, and today the general feeling is that investors are being required to bear a larger share than in the past.

Because of increases both in the level of business risk and in the share borne by investors, the utilities should have begun to raise their equity ratios back in the 1960s. However, as the top section of Table 1 shows, equity ratios actually fell from 1965 to 1975, when business risk was rising most rapidly, but then rose after 1975. Both total earnings and the amount retained increased, and market-book ratios moved up to or above one, making it rational to issue common stock. Even more important, construction programs slowed, so the equity buildup was not offset by an increase in debt, permitting equity ratios to rise. Currently, the average electric or gas company has a stronger equity ratio than in 1965, while the telephone companies are moving back toward their earlier levels.

Table 1

Equity Ratios in the Utility Industries

A. 1965-83

	Equity Ratios			
	Electric	Gas	Telephone	Industrials
1965	36%	44%	66%	75%
1975	33	39	45	64
1983	39	47	55	65

B. 1981-89

	Equity Ratios			
	Electric (East)	Gas	Telephone (Entire Industry)	Industrials
1981	38%	50%	51%	64%
1983	40	50	54	65
1985E	42	52	56	NA
1986E	42	52	57	NA
1989E	43	52	58	NA

Sources Section A: Compustat. The electric and gas data represent weighted average industry data on a book value basis. The telephone data reflect only American Telephone and Telegraph Company, which represented about 80 per cent of the industry prior to 1984. Section B: Value Line April 25, 1986, October 11, 1985, March 28, 1986. The telephone data reflect the entire industry as reported by Value Line.

The timing of capital structure changes differed significantly among companies. Those electrics which completed their construction programs in the late 1970s or early 1980s had a head start building up their equity ratios, and several of them presently have equity ratios in the 50 per cent range versus the industry average of 42 per cent. Those differences have prompted hearings by some commissions and have even led to regulatory caps on equity ratios.

The telephone companies, especially the Bell regional holding companies, have also come under study. It has been observed (1) that the telcos have higher equity ratios than the electrics and (2) that the telcos' equity buildup over the last ten years has been especially pronounced. This has raised the question of whether some telcos have "too much" equity. However, there are significant differences between telephone and electric companies, and one can argue that the telcos are exposed to more business risk than the nonnuclear-construction segment of the electric industry, and, consequently, that the telcos should use more equity. Indeed, Judge Greene took exactly that position when he decreed that the regional holding companies should be spun off from AT&T with a *minimum* of 55 per cent common equity. (The average electric at the time (1983) had a 40 per cent common equity ratio and a total equity ratio, including preferred, of about 50 per cent.)

Capital Structure Theories

Finance theory provides helpful insights into capital structure issues, but the theory leaves many key questions unresolved. In his 1983 presidential address to the American Finance Association, Professor Stewart Myers [9] suggested that finance theory can provide useful insights into the factors that determine an appropriate capital structure, but he also noted that one cannot use finance theory either to specify the effect of leverage on the cost of capital or to identify the optimal capital structure for a given company. Capital structure decisions must be made on the basis of informed judgement and market data, not by mathematical formulas derived from theory. Still, finance theory does provide insights which can help managers make better judgements.

Capital structure theory has been developed along two major lines:

1) *Trade-offs Between Tax Savings and the Costs of Financial Distress.* The tax savings-financial distress trade-off theory is associated with Franco Modigliani and Merton Miller, and it postulates that the optimal capital structure for a firm can be established by balancing the tax savings that result from the use of debt versus the drawbacks of leverage associated with various aspects of financial distress.
2) *Signaling, or Asymmetric Information, Theory.* This theory postulates (1) that managers and investors have different information about firms and their prospects, (2) that investors generally view an equity offering as a sign that the issuing firm's prospects are not bright, and (3) that investors therefore lower the price of a firm's stock and consequently raise its cost of equity when a new stock offering is announced. From this it follows that firms should use less debt than they otherwise would during "normal" times so as to build "reserve borrowing capacity" that can be used when above average amounts of funds are needed.

Both theories have merit, and both should be taken into account when establishing capital structure targets.

The Relationship Between Financial Leverage And the Cost of Equity

Theoretical Studies

Several theories, all of them rooted in the classic propositions set forth by Modigliani and Miller (MM) in 1958 and 1963 [7, 8], have been proposed to explain the effect of leverage on the cost of equity. All of the theories agree that the cost of equity increases as a firm uses more and more debt. However, the exact specification of the relationship depends on the underlying assumptions, and no one knows which set of assumptions is most correct, or even if any of the assumption sets is good enough for practical applications.

Figure 1 and its accompanying notes show the relationship between financial leverage and the cost of equity for an electric utility under perhaps the three best known theories. We do not present this material to indicate what we believe the true relationship to be; rather, we use it to demonstrate the huge differences between three popular theories.

Several others have relaxed MM's assumptions, which makes the model more realistic, but the modified models do not provide specific, mathematically precise formulas into which real-world data can be inserted to produce "answers." As a rule, though, the alternative trade-off theories suggest results which lie between the extremes shown in Figure 1.

Empirical Regression Studies

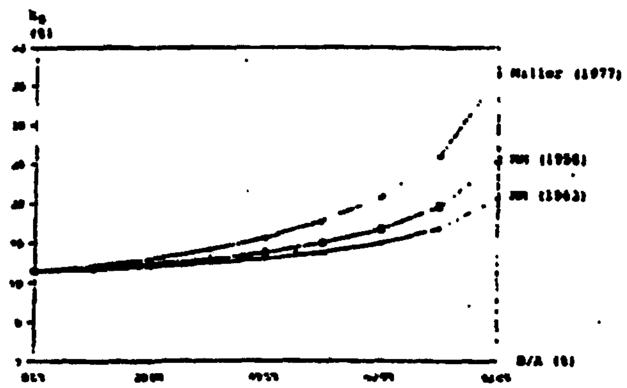
When it became clear that theory could not be used to establish the relationship between leverage and the cost of equity, researchers turned to empirical studies. Table 2 gives predictions based on the three main versions of the trade-off theory and then shows, for comparative purposes, results based on several key empirical studies [1, 2, 3, 4, 5, 10]. The empirical results show the same kind of variation as the theories, and while the empirical analyses all show that equity costs increase with leverage, the increases are generally smaller than the theories would predict.

As a part of the Public Utility Research Center study, L. C. Gapenski [3] conducted a new, updated statistical analysis of the empirical relationship between capital costs and financial leverage. Basically, Gapenski found that an increase in the debt-to-total-assets ratio from 40 to 50 per cent resulted in an increase in the cost of equity of about 72 basis points when leverage is measured in terms of expected book values. As Table 2 shows, Gapenski's new findings are consistent with the earlier empirical works.

It should be noted that a bias exists in all regression studies if the independent variables are measured with error, as they almost certainly are in the case of cost of capital studies, where most of the variables are proxies which are supposed to measure investors' expectations about future events and conditions. This measurement error bias causes all regression studies, ours included, to understate the true relationship between leverage and the cost of equity. It is impossible to determine the exact size of the bias, but we conducted several substudies on this effect. We concluded that, once the measurement error bias is eliminated, the best estimate

Figure 1

Theoretical Relationships Between Financial Leverage and the Cost of Equity For an Electric Utility



(D+P)/A	(D+P)/E	MM (1958)	Cost of Equity MM (1963)	Miller
0%	0.00	11.50%	11.50%	11.50%
10	0.11	11.89	11.76	12.19
20	0.25	12.38	12.08	13.06
30	0.43	13.00	12.49	14.17
40	0.67	13.83	13.04	15.65
50	1.00	15.00	13.81	17.72
60	1.50	16.75	14.97	20.83
70	2.33	19.67	16.89	26.01
80	4.00	25.50	20.74	36.38

Notes to Figure 1:

1. For these calculations we assume that the company uses only debt and common equity.

2. Capital structure ratios must be measured in market value terms to apply the MM and Miller equations. For a public utility operating under "perfect," lag-free regulation, common equity market values must be equal to book values. For unregulated firms, the benefits of leverage (tax savings) accrue to stockholders and result in higher stock prices. For utilities, tax benefits accrue to customers, so market values remain equal to book values.

3. All calculations of cost of equity, k_s, assume that k_u = cost of equity to an unlevered electric utility = 11.5 per cent, k_d = cost of debt = 8 per cent, and T = marginal tax rate = 34 per cent.

4. Both MM and Miller assume that k_d for the leveraged firm is equal to k_d of the unlevered firm; that is, k_d = 8 per cent regardless of the level of debt financing.

5. In their 1958 work [7], MM assumed zero taxes, and they developed the following equation, which we used to calculate the Column 1 values:

$$\begin{aligned} k_s &= k_u + (k_u - k_d)(D/E) \\ &= 11.5\% + (11.5\% - 8\%)(D/E) \\ &= 11.5\% + 3.50(D/E). \end{aligned}$$

Here D = market value of the firm's debt, E = market value of equity, and A = D + E = total market value of the firm's assets.

6. MM in 1963 [8] brought corporate taxes into the analysis, but no personal taxes, and they then developed this equation, which we used to calculate the Column 2 values:

$$\begin{aligned} k_s &= k_u + (k_u - k_d)(1 - T)(D/E) \\ &= 11.5\% + (11.5\% - 8\%)(0.66)(D/E) \\ &= 11.5\% + 2.31(D/E) \end{aligned}$$

7. Miller in his 1977 work [6] assumed corporate and personal taxes; the Column 3 values were calculated using this equation:

$$\begin{aligned} k_s &= k_u + [k_u - (1 - T)k_d](D/E) \\ &= 11.5\% + [11.5\% - (1 - 0.34)8\%](D/E) \\ &= 11.5\% + 6.22(D/E) \end{aligned}$$

change in the debt ratio from 40 to 50 per cent is a 120 basis point change in the cost of equity.

The Bond Rating (Risk Premium) Method

We also used a risk premium approach to estimate the effects of changes in leverage on the cost of equity. Here we combined the bond rating guidelines published by Standard & Poor's with interest rates on bonds with different ratings. For the electric utilities, each percentage point change in the debt-to-capital ratio results in a 7.8 basis point change in interest rates within the 42.5 to 48 per cent debt ratio range, and a ten basis point increase for debt ratios within the 48 to 54 per cent range. The data did not permit analysis outside the 42.5 to 54 per cent debt ratio range, so we cannot state exactly what would happen to interest rates if debt were below 42.5 or above 54 per cent. However, assuming that the 7.8 basis point adjustment also applies in the 42.5 to 40 per cent range, a change in the debt ratio from 40 to 50 per cent would cause the cost of debt to change by 82 basis points:

$$\begin{aligned} \text{Change in cost of debt} &= 2.5(7.8) + 5.5(7.8) + 2(10) \\ &= 82.4 \text{ basis points} \end{aligned}$$

This methodology can be extended to estimate the effects of leverage on the cost of equity. We know that the same fundamental factors that affect the riskiness of a company's bonds also affect the riskiness of its stock. Therefore, if something occurs to cause the riskiness and consequently the cost of the firm's debt to increase, then the cost of its equity will also rise. Most of the work in finance theory, as well as common sense, suggests that the effect of an increase in leverage is greater on the cost of equity than on the cost of debt. As long as operating income exceeds interest charges, changes in operating income have no effect on bondholders' returns, but any change whatever affects common stockholders. For this reason, at very low debt ratios, adding more debt has little effect on a bond's risk and required return, but the additional debt would affect stockholders.

Our studies indicate that if a ten percentage point increase in the debt ratio, from 40 to 50 per cent, would increase the cost of debt by 82 basis points, then the effect on the cost of equity would be 30 to 40 basis points greater. Therefore, a debt ratio increase from 40 to 50 per cent would cause the cost of equity to increase by from 112 to 122 basis points.

The Public Utility Research Center Capital Structure Model

From a regulatory viewpoint, the key issue is capital structure's long-run effect on revenue requirements. To assess this effect, we developed a Lotus 1-2-3 model

Table 2

Results of Prior Empirical Studies Compared To Theoretical Results

Theoretical Studies	Increase in Equity Cost When Debt-to-Total-Assets Ratio Increases from 40 to 50 Per Cent
MM (1958)	115 basis points
MM (1963)	62
Miller (1977)	237
Average	138
Empirical Regression Studies	
Brigham & Gordon (1968)	34
Gordon (1974)	45
Robichek et al. (1973)	75
Mehta et al. (1980)	109
Gapenski (1986)	72
Average	67
Risk Premium	
Brigham, Shome, & Vinson (1985)	120

NOTE The theoretical models (MM and Miller) were fitted using 1986 data, and the regression studies were all adjusted to reflect changes in interest rates between the time the studies were conducted and 1986.

which tests the sensitivity of revenue requirements and other output variables to capital structure changes. The most important inputs to the 1-2-3 model are the relationships between leverage and capital costs. We assumed a beginning capital structure of 48 per cent debt, 10 per cent preferred, and 42 per cent common stock. Beginning embedded costs are 9 per cent for debt and 8 per cent for preferred. Marginal costs, *assuming no change in capital structure*, are assumed to be 9 per cent for debt, 8 per cent for preferred, and 13.5 per cent for common equity.[2]

Of course, all these values could be changed, and any capital structure change, along with varying assumptions about capital cost rates, could be examined. We report in this article the results of one capital structure change — a five percentage point decrease in debt from 48 to 43 per cent. Thus, the firm's capital structure moves to 43 per cent debt, 10 per cent preferred (the preferred ratio is held constant), and 47 per cent common equity. We assume that this decrease in leverage will lower debt and preferred costs by 40 basis points. Then, we examine three different situations regarding the impact of the capital structure change on equity costs. In the "most likely" case, we assume that the equity cost decreases by 50 basis points upon announcement of the capital structure change. However, we also show the results if the decrease in equity cost is as low as 25 basis points (the low-sensitivity case) or as high as 75 basis points (the high-sensitivity case).

Table 3 gives the key results of the model runs for the electrics. Similar runs were made with a version of the model adapted to telephone companies. Data were generated for every year from 1986 to 2001, but to avoid unnecessary detail, only selected years are shown. Section I focuses on the pretax weighted average cost of capital, Section II on revenue requirements, Section III on monthly residential bills for a 1,000-kilowatt-hour customer, and Section IV on pretax interest coverage ratios.[3]

The most striking feature of the results is that capital structure changes have very little effect on any of these key variables. In 2001, sixteen years after the decision to change the capital structure, revenue requirements differ between the base case and the most likely case by only $18 million on a base of about $11.6 billion, or by only 16/100th of one per cent, and the average customer's bill differs by only 29 cents on a base of $180.80, again, only 16/100th of one per cent. Differences are even smaller in the near term. In view of the uncertainty over the values which should be assigned to the inputs, these differences are trivial.

The overriding conclusion to be drawn from our analysis is this: Capital structure changes have little impact on a utility's revenue requirements or its customers' bills. Capital structure does affect the cost rates of both debt and equity, but changes in those variables are offset by changes in the weights of each capital structure component.

We also used the model to study the effects of changes in inflation, fuel, labor, and fixed costs such as depreciation. The effects of changes here are dwarfed by the impact of capital structure changes. *That, in turn, led to the conclusion that the primary focus of capital structure decisions should be on ensuring that financial constraints do not hinder efficient operations, not on the effects of capital structure per se on revenue requirements.*

Capital Structure and Construction Cycles

Finance theory suggests that the capital structure should be set so as to obtain the maximum tax benefits from debt consistent with maintaining a reserve of borrowing capacity sufficient to permit efficient financing

[2]We should issue a disclaimer at this point: We have made no effort whatever to estimate the current cost of equity for any given utility or for the industry average. Therefore, one should not assume that we believe the current cost of equity is 13.5 per cent or any other value.

[3]The weighted average cost of capital given in Table 3 is different from the one discussed in rate cases. The one we show "grosses up" the return on preferred and common to a before tax basis. If the grossed up WACC is at a minimum, then the sum of interest, preferred dividends, return to common, and income taxes will be minimized

TABLE 3

Key Results of the Energy Model Runs

I. Pretax WACC

	1986	1987	1990	1995	2000	2001
Most Likely Case	13.80%	13.89%	14.17%	14.21%	14.17%	14.16%
Low-sensitivity Case	13.96%	14.06%	14.34%	14.39%	14.35%	14.34%
High-sensitivity Case	13.65%	13.73%	13.99%	14.03%	13.99%	13.99%
Base Case: No Capital Structure Change	14.12%	14.12%	14.12%	14.12%	14.12%	14.12%

II. Revenue Requirements

	1986	1987	1990	1995	2000	2001
Most Likely Case	$4.135	$4.437	$5.482	$7.724	$10.874	$11.845
Low-sensitivity Case	$4.147	$4.450	$5.500	$7.750	$10.911	$11.884
High-sensitivity Case	$4.122	$4.423	$5.464	$7.697	$10.838	$11.806
Base Case: No Capital Structure Change	$4.155	$4.450	$5.467	$7.704	$10.856	$11.827

III. Average Bill

	1986	1987	1990	1995	2000	2001
Most Likely Case	$89.40	$94.06	$109.50	$139.73	$178.19	$187.08
Low-sensitivity Case	$89.67	$94.34	$109.86	$140.21	$178.80	$187.71
High-sensitivity Case	$89.13	$93.75	$109.13	$139.26	$177.59	$186.45
Base Case: No Capital Structure Change	$89.85	$94.34	$109.21	$139.38	$177.89	$186.79

IV. Pretax Coverage Ratio

	1986	1987	1990	1995	2000	2001
Most Likely Case	3.28	3.39	3.73	3.87	3.89	3.89
Low-sensitivity Case	3.32	3.43	3.77	3.91	3.94	3.94
High-sensitivity Case	3.25	3.35	3.68	3.82	3.84	3.84
Base Case: No Capital Structure Change	3.34	3.34	3.34	3.34	3.34	3.34

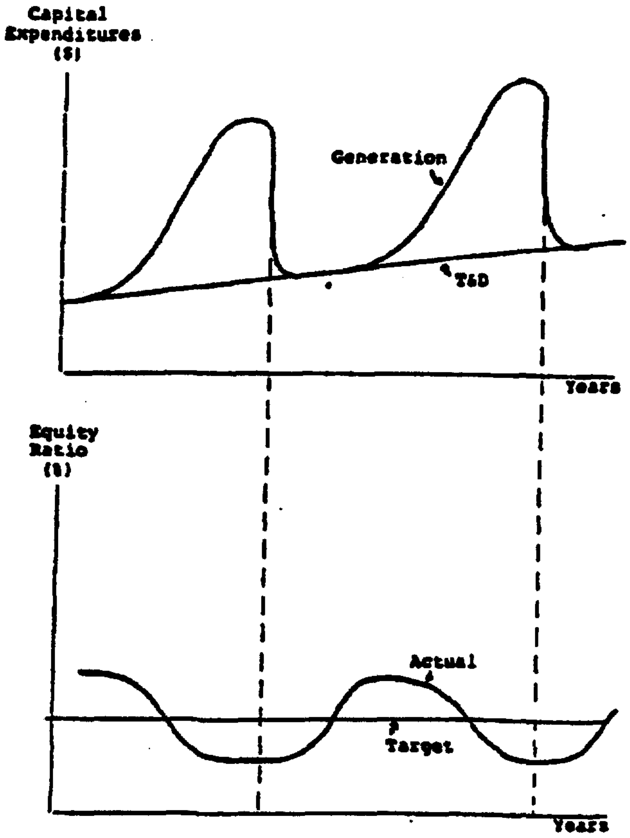
during times of stress. If a company is strong, it can raise funds at a reasonable cost from many different sources, but if it is weak, it cannot get money on reasonable terms except on a secured basis, and the better the security, the better the interest rate and terms. Therefore, in times of stress utilities need access to the investment grade first mortgage bond market.

In the minds of most investors, the greatest risks for an electric utility are associated with construction. If a company has all of its generating plants in the rate base earning a cash return, then it will probably be regarded as a strong company. On the other hand, if it is in the midst of a major construction program, it will be perceived as facing risks. Planning and building a baseload generating station generally takes from eight to twelve years, and much can happen during that time — costs can escalate, load growth can decline, relative fuel prices can change, new technologies can be introduced, environmental problems can surface, and so on. Further, investors know that if things work out as planned or better, the company will be allowed to earn its cost of capital, but no more, while if things do not work out as well as anticipated, full recovery may not be permitted. So, when a company begins a major new construction program, that very fact will cause it to lose favor in the capital markets.

Now consider Figure 2. The top section shows the long-run construction expenditure forecast for a hypothetical utility. The company projects a smooth, slowly growing level of expenditures for transmission and distribution facilities, and periodically it must build a new generating unit (or refurbish an old unit). The lower graph shows the equity ratio situation. The long-run target ratio depends primarily on basic business risk, which we assume is constant. However, the actual equity ratio should cycle about the long-run target level, rising when construction activities are low, then declining as the company goes into its peak expenditure pe-

Figure 2

Relationship Between Construction Expenditures And Capital Structure



riod, because peak expenditures would be financed primarily by debt.[4]

The pattern shown in Figure 2 is consistent both with finance theory and with what utilities have been doing in recent years, but several questions are suggested by the graphs: (1) At what level should the long-run target capital structure be set? (2) How far above or below the long-run target should the actual equity ratio go? (3) Should the same targets be used by all utilities? (4) For regulatory purposes, should the target or the actual capital structure be used to determine the allowed rate of return? These points are addressed next.

1) *The long-run target*. It is critically important that a utility be able to raise capital under adverse conditions, and investors look to bond ratings as a guide to a company's creditworthiness. Putting those two facts together suggests that the long-run target, under 1986 conditions, should be consistent with the guidelines for a "double A" bond rating.

The virtual impossibility of "proving" what the optimal capital structure is, combined with the fact that a company's own circumstances have a bearing on its optimal capital structure, suggests that considerable scope should be allowed for managerial discretion. Conditions in the utility industries are currently in a state of flux, making it important that the capital structure target be reviewed periodically.

2) *Deviations about the target*. Deviations from the target capital structure will occur because of such random factors as bond maturities and capital market fluctuations, and because of construction cycles. Such deviations are necessarily company specific; for example, a relatively small electric company would normally experience wider capital structure changes than a larger company because a new plant would represent a larger percentage of the small company's total capital. Still, it would seem prudent to plan to keep the common equity ratios at least in the "A" range. At the high end, we would question the merits of an electric having an equity ratio above the low 50s on the grounds that it would be giving up substantial tax savings and getting little in return.

3) *The regulatory capital structure*. Assuming a company is operating within a reasonable range, its actual capital structure (or the one forecasted during the period when rates will be in effect) should be used for rate-making purposes. This would minimize the long-run cost of capital, because investors have more confidence in the impartiality of regulation when they see actual as opposed to hypothetical data being used.

Tax Law Changes

Taxes have an important effect on the optimal capital structure, and our tax system will soon undergo a major change. Therefore, we considered how the new tax laws will affect capital structure decisions. We began by noting that four aspects of the new tax legislation will affect capital structure decisions: (1) the change in corporate tax rates from a statutory rate of 46 per cent to a new rate of 34 per cent; (2) changes in personal tax rates, including the elimination of the differential treatment of capital gains and ordinary income; (3) changes in depreciation rates, and (4) elimination of the investment tax credit.

Effects of Changes in the Corporate Tax Rate

Modigliani and Miller, in 1963, demonstrated that one major reason for including debt in the capital structure

[4] The actual equity ratio might also deviate from the target ratio as a result of varying conditions in the debt and equity markets, bond maturities, refunding opportunities, and the like. Also, as diversification becomes more important, opportunities outside the utility will probably influence holding company decisions with regard to the utility's payment of dividends to the parent, and hence will affect both the utility and the consolidated capital structures.

is the fact that interest is deductible. Modigliani and Miller also showed that the tax benefit of debt is directly proportional to the corporate tax rate — the higher the corporate tax rate, the greater the advantage of the interest tax shelter, and the more debt firms should have in their capital structures. The old corporate tax rate was 46 per cent, while the new rate is 34 per cent. Other things held constant, this change in the corporate tax rate should lead to the use of less debt and more equity, that is, to a higher equity ratio.

The corporate rate change can also be considered in terms of revenue requirements. Suppose a company has \$100 of rate base assets, \$50 of debt with a cost of k_d = 10 per cent, \$50 of equity with a cost of k_s = 15 per cent, and a tax rate of T = 46 per cent. The required rate of return on assets will be 18.89 per cent:

$$\text{Required Return on Assets (ROA)} = w_dk_d + w_s[k_s/(1 - T)]$$
$$= 0.5(10\%) + 0.5(15\%/0.54)$$
$$= 0.5(10\%) + 0.5(27.78\%)$$
$$= 18.89\%$$

$$\text{Revenue Requirements To Satisfy Investors} = 0.1889(\$100) = \$18.89$$

If the company earns 18.89 per cent on its \$100 rate base, then it can pay \$5 of interest to bondholders, \$6.39 of taxes, and have \$7.50 left for stockholders.

Now let the tax rate decline to 34 per cent. Assuming k_d and k_s are unchanged at 10 per cent and 15 per cent, respectively, the overall cost of capital will decline to 16.36 per cent:

$$\text{Required Return on Assets (ROA)} = 0.5(10\%) + 0.5(15\%/0.66)$$
$$= 0.5(10\%) + 0.5(22.73\%)$$
$$= 16.36\%$$

$$\text{Revenue Requirements} = 0.1636(\$100) = \$16.36$$

Revenue requirements fell because the pretax cost of equity declined as a result of the tax rate reduction. Since the cost of equity declined, but the cost of debt remained constant, it seems reasonable to think that if the company's optimal capital structure was 50-50 before the tax rate change, then after the change the company should use somewhat more equity.

The tax rate change also affects coverage ratios. Our hypothetical company's pretax coverage ratio when the 46 per cent tax rate was in effect was 3.78x:

$$\text{Coverage} = \frac{w_dk_d + \frac{w_sk_s}{1 - T}}{w_dk_d}$$

$$= \frac{0.5(10\%) + \frac{0.5(15\%)}{0.54}}{0.5(10\%)} = 3.78x$$

When the new tax rates take effect, the coverage ratio will decline to 3.27x:

$$\text{Coverage} = \frac{0.5(10\%) + \frac{0.5(15\%)}{0.66}}{0.5(10\%)} = 3.27x$$

Thus, the corporate tax rate change could be expected to lead to a decline in utilities' coverage ratios. That, in turn, suggests that companies will need to increase their equity ratios somewhat to offset the tax-induced coverage decline.

Effects of the Changes in Personal Tax Rates

In the preceding section we saw that the reduction in the corporate tax rate will, other things held constant, lead companies to increase their equity ratios. Of course, all other things are not constant, and one of those things is the personal tax rate. There is a possibility that changes in personal tax rates will lead to changes in the relative costs of debt and equity, and that these changes could affect the optimal capital structure.

The top personal tax rate will drop from T_p = 50 per cent to T_p = 28 per cent, but the top capital gains tax rate will rise from T_g = 20 per cent to T_g = 28 per cent. Those changes will clearly benefit bondholders — for a top bracket bondholder, the after-tax return on a 10 per cent bond will rise from 5 per cent to 7.2 per cent:

$$\text{Old After-tax Return on Debt:} \quad k_d(1 - T) = 10\%(0.5) = 5$$
$$\text{New After-tax Return on Debt:} \quad k_d(1 - T) = 10\%(0.72) = 7.2\%$$

The effect on stockholders depends on how the equity return is divided between dividend yield and capital gains from growth. For example, if k_s = D/P + g = 10% + 5% = 15%, and the investor has a one-year holding period, then the after-tax return on the stock will change as follows:

$$\text{Old After-tax Return} = 10\%(1 - Tp) + 5\%(1 - Tg)$$
$$= 10\%(0.5) + 5\%(0.8)$$
$$= 9\%$$

$$\text{New After-tax Return} = 10\%(0.72) + 5\%(0.72) = 10.8\%$$

Now notice that the after-tax return on bonds has risen by $(7.2\%/5\%) - 1 = 44\%$, but the after-tax return on equity has increased by only $(10.8\%/9\%) - 1 = 20\%$. Thus, the personal tax rate change is over twice as beneficial to debt as to equity. Note, though, that these results are quite sensitive to the stockholders tax bracket, to the split between dividend yield and growth, and also to the length of the investor's holding period.[5]

These personal tax rate changes will undoubtedly affect capital market rates, and they will undoubtedly cause the market cost of debt to fall relative to the market cost of equity. However, we have no idea of the magnitude of these effects. If utility stock prices and bond interest rates are determined primarily by such institutional investors as pension funds, which are in the zero tax bracket, and by low-bracket retirees, then there will be no personal tax effects whatever. Our guess is that personal tax rate effects will not turn out to be very important, that the market costs of debt and equity will not be significantly affected by the tax law changes, and hence that the personal tax rate changes will not have a material effect on capital structure decisions.

Depreciation and the Investment Tax Credit

As we noted earlier, capital structures can be affected by where a company is in its construction program and by its available cash flows. Therefore, we were concerned about how the tax law changes might affect cash flows and hence capital structures.

The elimination of the investment tax credit (ITC) and the lowering of depreciation rates will both have an adverse effect on utilities' cash flows. However, most utilities have completed their major construction programs and many of those that are still building plants have gotten their projects "grandfathered" in under the transition rules, so that they will still get the ITCs and can also depreciate the plants using the old rates. We conducted a telephone survey of a number of utility companies, and based on that survey we concluded that the loss of the ITCs and the changes in depreciation rates will not have a material adverse effect on most companies' cash flows over the next five or six years, but these changes will have a very serious adverse effect when the next round of generation construction begins.

This situation suggests to us that it is even more important, under the new tax laws, for utilities to increase their equity ratios now, while construction is low, because ITCs and deferred taxes will not be available to help finance the next round of base-load construction.

On balance, the 1986 tax changes should, if anything, lead to further increases in equity ratios.

Conclusions

Our study was designed (1) to examine the effects of capital structure on the cost of equity and (2) to consider the proper range of capital structures for utilities. We examined past theoretical and empirical regression studies bearing on these issues; we performed some empirical studies of our own; and we developed a computer model which permitted us to study the effects of alternative capital structures on revenue requirements and customers' bills.

Our major conclusion was that capital structure decisions, within the range over which most utilities operate, have insignificant effects on revenue requirements. Operating decisions, on the other hand, can and do have a major effect on revenue requirements. This suggests that capital structure decisions should be focused primarily on ensuring that financial constraints do not hinder operations.

The electric utilities go through major construction cycles, and their actual capital structures should vary from the long-run targets over these cycles. When a major plant is completed and placed in the rate base, internally generated cash flows should exceed construction expenditures, and the equity ratio should be built up and should peak just before the start of the next major construction program. During construction, the company should finance heavily with debt, thus causing the equity ratio to decline, and this ratio should bottom out just as the construction program is completed.

We found that the cost of equity for an electric company changes by an average of 12 basis points per percentage point change in the common equity ratio, assuming the company is within the 40 to 50 per cent equity ratio range. The basis point change is smaller toward the high end of the equity ratio range, so an increase in equity from 49 to 50 per cent would only lower the cost of equity by about seven basis points, but an increase in the ratio from 40 to 41 per cent would lower the cost of equity by about 15 basis points. Both theory and the available evidence suggest that the same general situation would also exist for the telephone companies, but within a higher equity ratio range.

Finally, we considered the effects of the 1986 tax legislation. The direct effects of the tax changes will be to reduce the tax shelter benefits of corporate debt, to lower the pretax cost of equity relative to the cost of debt, to reduce cash flows available to support construction, and to lower coverage ratios. All of these changes will increase the optimal equity ratio. However, changes in

[5]If an investor holds a stock until he or she dies, then the capital gains tax is avoided entirely, and the after-tax return on our illustrative stock would be 10% (.72) + 5% = 12.2% rather than 10.8%.

... ... cost of debt relative to the market cost of equity, and that could offset at least some of the pressure to increase equity ratios. On balance, though, the effect of the tax law changes should be to raise equity ratios over the otherwise optimal levels.

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Small-Scale Gas-fired Cogeneration Disappeared in 1986

The "Cogeneration Pricing Report" reports that qualifying facility (QF) filings for gas-fired cogeneration systems smaller than 500 kilowatts have practically disappeared in 1986. The number of QF filings with the Federal Energy Regulatory Commission have dropped from a 1985 peak of 115 projects to only one project during the first eight months of 1986.

According to the October issue of the "Cogeneration Pricing Report," small gas-fired cogeneration activity steadily and dramatically increased after 1981. The number of QF applications for gas-fired systems smaller than 500 kilowatts increased from two projects in 1981 to an annual total of 115 projects by the end of 1985. However, through the first eight months of 1986 QF status was sought for one gas-fired cogeneration system smaller than 500 kilowatts.

This dramatic drop-off in small cogeneration activity is largely tied to selected provisions of the Tax Reform Act of 1986. The new tax law will directly affect the economics of small, gas-fired cogeneration projects, especially in the areas of depreciation and the investment tax credit (ITC).

Under the accelerated cost recovery system of depreciation offered by earlier law, small projects are depreciated over a ten-year period. With the new law, the actual service life of the equipment will be used as the basis for depreciation, typically fifteen years on these systems. An earlier 10 per cent business investment tax credit will be eliminated under the new law. However, a series of transition rules include exemptions from the more stringent provisions of the Tax Reform Act for certain projects. Specifically, projects that were certified by the FERC as QF before January 1, 1986, qualify for the ITC. Further, projects that were certified as QF on or before March 1, 1986, would still qualify for accelerated depreciation. All of the small gas projects receiving transition rule benefits must be in service by January 1, 1991.

The pending tax law changes contributed to a rush of applications for certification as a QF prior to the end of 1985. Project developers or owners were accelerating their plans to file for QF status to beat the year-end expiration of benefits. This partially explains the frenetic activity prior to the end of that year and the lack of activity during the early part of 1986. It is still somewhat surprising, however, that only one application was made during the first eight months of 1986.